

AMENDMENT

To : Examiner of the Patent Office

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1. Identification of the International Application

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4. Item to be Amended: Specification and Claims

5. Subject Matter of Amendment

(1) In Specification p.3, Line 28 – p.4, Line 15 (English translation p.4 [0011] Line 1 – p.5 [0012] Line 7), “In order to achieve the above mentioned first purpose, – and the third fluorocarbon resin layer is FEP.” is deleted, and the sentence written below is added between p.4, Lines 15 and 16 (English translation p.4 [0011]).

-- In order to achieve the above mentioned first and second

purposes, the first embodiment of the present invention is characterized in that the structure of a photocatalyst sheet of the present invention comprises: a substrate made of glass fiber; a first fluorocarbon resin layer made of PTFE coated on said substrate; a second fluorocarbon resin layer made of either one of PTFE, FEP, or PFA coated on said first fluorocarbon resin layer; and a third fluorocarbon resin layer made of FEP containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on said second fluorocarbon resin layer, of which said photocatalysts have the part exposed on said third fluorocarbon resin layer, and the ratio of said photocatalysts in said third fluorocarbon resin layer is 10 – 60 weight %, and the surface of the fluorocarbon resin layer containing said photocatalysts of said photocatalyst sheet has water repellency upon ultraviolet light irradiation.

In the embodiment described above, the surface state of the substrate made of glass fiber is preferably either smooth, rough, or mesh-like. The second fluorocarbon resin layer may contain photocatalysts.

Preferably, the photooxidation ability of the surface of the fluorocarbon resin layer containing photocatalysts of a photocatalyst sheet is such that, when oleic glyceride is coated on said surface of a fluorocarbon resin layer, and ultraviolet light is irradiated onto said surface by $1\text{mW}/\text{cm}^2$, the rate of decomposition of said oleic glyceride is $0.1\text{mg}/\text{cm}^2$ day or more.

Preferably, the photoreduction ability of the surface of the fluorocarbon resin layer containing photocatalysts of a photocatalyst sheet is such that, when said photocatalyst sheet is soaked in the 0.1N (normal) silver nitrate aqueous solution, and ultraviolet light is irradiated for one minute onto the surface of said fluorocarbon resin layer containing said photocatalysts by $1\text{mW}/\text{cm}^2$, the color difference change is $\Delta E^* \geq 1$.

The contact angle of the surface of the fluorocarbon resin layer containing photocatalysts is preferably about 90 degrees or more. The thickness of the fluorocarbon resin layer containing photocatalysts is

preferably 1 μm or more. --

(2) In Specification p.4, Lines 19 and 20 (English translation p.5 [0012] Lines 12 – 15), “high antifouling property is achieved by the redox reaction by the photocatalyst exposed on the surface of the third fluorocarbon resin layer of the photocatalyst sheet when irradiated with the ultraviolet light involved in the sunshine.” is amended as shown below.

-- the surface of the fluorocarbon resin layer containing photocatalysts contained in the uppermost layer of the photocatalyst sheet has water repellency upon ultraviolet light irradiation, and high antifouling property is given by the redox reaction when the photocatalysts exposed on the surface of the third fluorocarbon resin of the photocatalyst sheet are irradiated with the ultraviolet light involved in the sunshine.--

(3) In Specification, the description from p.4, Line 21, “The embodiment of the present invention” to p.5, Line 16 “and high antifouling property can be attained.” (English translation p.5 [0013] Line 14 – p.6 [0014] Line 8) is deleted.

(4) In Specification p.5, Lines 17 – 21 (English translation p.6 [0015] Lines 1 – 9), “In order to achieve the above-mentioned second purpose, the third embodiment of a photocatalyst sheet of the present invention is that it comprises: ----- Said photocatalyst sheet preferably has the surface of the fluorocarbon resin layer containing said photocatalyst of said photocatalyst sheet is water repellant.” is amended as shown below.

-- In order to achieve the above mentioned first purpose, the second embodiment of the present invention is characterized in that the structure of a photocatalyst sheet of the present invention comprises: a substrate; a first fluorocarbon resin layer coated on the substrate; a second fluorocarbon resin layer coated on the first fluorocarbon resin layer; and a third fluorocarbon resin layer containing photocatalysts

consisting at least of titanium oxide (TiO_2 , TiO_3) coated on the second fluorocarbon resin layer, of which the third fluorocarbon resin layer has lower melting point than the first fluorocarbon resin layer, the photocatalysts have the part exposed on the third fluorocarbon resin layer, and the ratio of the photocatalysts in the third fluorocarbon resin layer is 10 – 60 weight %, and the third fluorocarbon resin layer is thermally weldable.

In order to achieve the above mentioned second purpose, the third embodiment of the present invention is such that the structure of a photocatalyst sheet of the present invention comprises: a substrate; a first fluorocarbon resin layer coated on the substrate; a second fluorocarbon resin layer coated on the first fluorocarbon resin layer; and a third fluorocarbon resin layer containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on the second fluorocarbon resin layer, of which the third fluorocarbon resin layer has lower melting point than the first fluorocarbon resin layer, the photocatalysts have the part exposed on the third fluorocarbon resin layer, and the ratio of the photocatalysts in the third fluorocarbon resin layer is 10 – 60 weight %, the surface of the fluorocarbon resin layer containing photocatalysts of the photocatalyst sheet is water repellent upon ultraviolet light irradiation, and the third fluorocarbon resin layer is thermally weldable.

In the embodiment described above, the substrate is preferably made of glass fiber, and its surface state is either smooth, rough, or mesh-like. The first fluorocarbon resin layer is made of PTFE, the second fluorocarbon resin layer is made of either one of PTFE, FEP, or PFA, and the third fluorocarbon resin layer is made of FEP.

Preferably, the melting point of the second fluorocarbon resin layer may be as high as, or higher than, that of the third fluorocarbon resin layer. In this case, the second and the third fluorocarbon resin layers may be made of identical fluorocarbon resin.

Preferably, the melting point of the first fluorocarbon resin layer may be as high as, or higher than, that of the second fluorocarbon resin layer. In this case, the first and the second fluorocarbon resin

layers may be made of identical fluorocarbon resin. Also, the second fluorocarbon resin layer may contain photocatalysts.

In order to achieve the above mentioned second purpose, the fourth embodiment of the present invention is characterized in that a photocatalyst sheet of the present invention has a substrate which is coated with fluorocarbon resin layers, at least its uppermost layer is coated with the fluorocarbon resin layer containing photocatalysts, and the surface of the fluorocarbon resin layer containing photocatalysts is water repellent upon ultraviolet light irradiation. --

(5) In Specification p.5, Lines 22 – 26 (English translation p.6 [0015] Line 10 – [0016] Line 3), “According to any of the embodiments mentioned above, ----- [0016] In the embodiment described above, the photocatalyst preferably has the exposed part on the fluorocarbon resin layer of the uppermost layer, or on the third fluorocarbon resin layer.” is amended as shown below.

-- By each of the embodiments described above, the combination of the first to the third fluorocarbon resin layers, which gives excellent thermal weldability between photocatalyst sheets, can be readily obtained. Especially when a substrate is glass fiber, the first fluorocarbon resin layer is PTFE, the second fluorocarbon resin layer is either one of PTFE, FEP, or PFA, and the third fluorocarbon resin layer is FEP, since FEP as the uppermost fluorocarbon resin layer containing photocatalysts has lower melting point than PTFE as the first fluorocarbon resin layer on the substrate side, photocatalyst sheets can be easily thermally welded to each other. Also, high antifouling property is given by the redox reaction when the photocatalysts exposed on the surface of said third fluorocarbon resin are irradiated with the ultraviolet light involved in the sunshine. Further, the surface of the fluorocarbon resin layer containing photocatalysts of the uppermost layer of a photocatalyst sheet can be given water repellency upon ultraviolet light irradiation. --

(6) In Specification p.6, Lines 20 – 29 (English translation p.7 [0018]

Line 1 – p.8 [0018], Line 15), “A manufacturing method of a photocatalyst sheet of the present invention comprises ----- the photocatalyst sheet with high thermal bondability and high antifouling property can be attained by coating the fluorocarbon resin layer containing the photocatalyst on the outermost surface of the substrate.” is amended as shown below.

-- A manufacturing method of a photocatalyst sheet of the present invention is that of a photocatalyst sheet, which comprises: a substrate made of glass fiber; a first fluorocarbon resin layer made of PTFE coated on the substrate; a second fluorocarbon resin layer made of either one of PTFE, FEP, or PFA coated on the first fluorocarbon resin layer; and a third fluorocarbon resin layer made of FEP containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on the second fluorocarbon resin layer, of which the photocatalysts have the part exposed on the third fluorocarbon resin layer, the ratio of the photocatalysts in the third fluorocarbon resin layer is 10 – 60 weight %, and the surface of the fluorocarbon resin layer containing the photocatalysts of the photocatalyst sheet is water repellent upon ultraviolet light irradiation, and said method is characterized to comprise a process of coating the first fluorocarbon resin layer on the substrate, a process of coating the second fluorocarbon resin layer on the first fluorocarbon resin layer, and a process of coating the third fluorocarbon resin layer containing photocatalysts on the second fluorocarbon resin layer.

Another manufacturing method of a photocatalyst sheet of the present invention is that of a photocatalyst sheet, which is characterized to comprise: a substrate made of glass fiber; a first fluorocarbon resin layer made of PTFE coated on the substrate; a second fluorocarbon resin layer made of either one of PTFE, FEP, or PFA coated on the first fluorocarbon resin layer; and a third fluorocarbon resin layer made of FEP containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on the second fluorocarbon resin layer, of which the photocatalysts have the part exposed on the third fluorocarbon resin layer, the ratio of the

photocatalysts in the third fluorocarbon resin layer is 10 – 60 weight %, and the surface of the fluorocarbon resin layer containing said photocatalysts of the photocatalyst sheet is water repellent upon ultraviolet light irradiation, and said method is characterized to comprise a process of coating the first fluorocarbon resin layer on the substrate, a process of coating the second fluorocarbon resin layer containing photocatalysts on the first fluorocarbon resin layer, and a process of coating the third fluorocarbon resin layer containing photocatalysts on the second fluorocarbon resin layer.

By said method of manufacturing, coating the third fluorocarbon resin layer containing photocatalysts on the uppermost surface of the substrate makes thermal welding easy, and the photocatalysts exposed on the third fluorocarbon resin layer have water repellency upon ultraviolet light irradiation, thereby a photocatalyst sheet having antifouling property can be manufactured at low cost.

Further, in case that the second fluorocarbon resin layer contains photocatalysts, since both the second and the third fluorocarbon resin layers contain photocatalysts, a photocatalyst sheet having excellent thermal weldability and antifouling property can be manufactured. --

(7) In Specification p.7, Lines 18 – 22 (English translation p.9 [0022] Lines 1 – 10), “A method of manufacture of the photocatalyst sheet of the present invention includes: a process to coat an uppermost layer of a substrate with a fluorocarbon resin layer containing a photocatalyst; and characterized in that the surface of said fluorocarbon resin layer containing the photocatalyst is water repellant. According to the manufacturing method mentioned above, since the uppermost surface of substrate is coated with the fluorocarbon resin layer containing the photocatalyst, the photocatalyst sheet can be provided at low cost. Its uppermost layer is water repellant and the high antifouling property, and can be easily thermally welded.” is deleted.

(8) In Claim p.27, Claim 1 (English translation p.34 Claim 1) is

amended as shown below.

- A photocatalyst sheet characterized in that it comprises:
 - a substrate made of glass fiber;
 - a first fluorocarbon resin layer made of PTFE coated on said substrate;
 - a second fluorocarbon resin layer made of either one of PTFE, FEP, or PFA coated on said first fluorocarbon resin layer; and
 - a third fluorocarbon resin layer made of FEP containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on said second fluorocarbon resin layer;
- of which said photocatalysts have the part exposed on said third fluorocarbon resin layer;
- the ratio of said photocatalysts in said third fluorocarbon resin layer is 10 – 60 weight %; and
- the surface of the fluorocarbon resin layer containing said photocatalysts of said photocatalyst sheet is water repellent upon ultraviolet light irradiation. --

(9) In Claim p.27, Claim 2 (English translation p.34 Claim 2) is amended as shown below.

- A photocatalyst sheet as set forth in Claim 1, characterized in that the surface state of said substrate made of glass fiber is either smooth, rough, or mesh-like. --

(10) In Claim p.27, Claim 3 (English translation p.34 Claim 3) is amended as shown below.

- A photocatalyst sheet as set forth in claim 1, characterized in that photocatalysts are contained in said second fluorocarbon resin layer. --

(11) In Claim p.27, Claim 4 (English translation p.34 Claim 4) is amended as shown below.

- A photocatalyst sheet as set forth in claim 1, characterized in that the photooxidation ability of the surface of said fluorocarbon resin

layer containing photocatalysts of said photocatalyst sheet is such that, when oleic glyceride is coated on said surface of fluorocarbon resin layer, and an ultraviolet light is irradiated onto said surface by $1\text{mW}/\text{cm}^2$, the rate of decomposition of said oleic glyceride is $0.1\text{mg}/\text{cm}^2$ day or more. --

(12) In Claim p.27, Claim 5 (English translation p.34 Claim 5) is amended as shown below.

-- A photocatalyst sheet as set forth in claim 1, characterized in that the photoreduction ability of the surface of said fluorocarbon resin layer containing photocatalysts of said photocatalyst sheet is such that, when said photocatalyst sheet is soaked in the 0.1N (normal) silver nitrate aqueous solution, and ultraviolet light is irradiated for one minute onto the surface of said fluorocarbon resin layer containing photocatalysts by $1\text{mW}/\text{cm}^2$, the color difference change is $\Delta E^* \geq 1$. --

(13) In Claim p.27, Claim 6 (English translation p.35 Claim 6) is amended as shown below.

-- A photocatalyst sheet as set forth in claim 1, characterized in that the contact angle of the surface of said fluorocarbon resin layer containing photocatalysts is about 90 degrees or more. --

(14) In Claim pp.27 – 28, Claim 7 (English translation p.35 Claim 7) is amended as shown below.

-- A photocatalyst sheet as set forth in claim 1, characterized in that the thickness of said fluorocarbon resin layer containing photocatalysts is $1\ \mu\text{m}$ or more.

(15) In Claim p.28, Claim 8 (English translation p.35 Claim 8) is amended as shown below.

A photocatalyst sheet characterized in that it comprises:
a substrate;
a first fluorocarbon resin layer coated on said substrate;
a second fluorocarbon resin layer coated on said first fluorocarbon resin layer; and

a third fluorocarbon resin layer containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on said second fluorocarbon resin layer;

of which said third fluorocarbon resin layer has lower melting point than said first fluorocarbon resin layer;

said photocatalysts have the part exposed on said third fluorocarbon resin layer;

the ratio of said photocatalysts in said third fluorocarbon resin layer is 10 – 60 weight %; and

said photocatalyst sheet can be thermally welded to said third fluorocarbon resin layer. --

(16) In Claim p.28, Claim 9 (English translation p.35 Claim 9) is amended as shown below.

-- A photocatalyst sheet characterized in that it comprises:

a substrate;

a first fluorocarbon resin layer coated on said substrate;

a second fluorocarbon resin layer coated on said first fluorocarbon resin layer; and

a third fluorocarbon resin layer containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on said second fluorocarbon resin layer;

of which said third fluorocarbon resin layer has lower melting point than said first fluorocarbon resin layer;

said photocatalysts have the part exposed on said third fluorocarbon resin layer;

the ratio of said photocatalysts in said third fluorocarbon resin layer is 10 – 60 weight %;

the surface of the fluorocarbon resin layer containing said photocatalysts of said photocatalyst sheet is water repellent upon ultraviolet light irradiation, and

said photocatalyst sheet can be thermally welded to said third fluorocarbon resin layer. --

(17) In Claim p.28, Claim 10 (English translation p.35 Claim 10) is amended as shown below.

-- A photocatalyst sheet as set forth in claim 8 or 9, characterized in that said substrate is made of glass fiber, its surface state is either smooth, rough, or mesh-like, said first fluorocarbon resin layer is made of PTFE, said second fluorocarbon resin layer is either one of PTFE, FEP, or PFA resin layer, and said third fluorocarbon resin layer is made of FEP. --

(18) In Claim p.28, Claim 11 (English translation p.35 Claim 11) is amended as shown below.

-- A photocatalyst sheet as set forth in claim 8 or 9, characterized in that the melting point of said second fluorocarbon resin layer is as high as, or higher than, that of said third fluorocarbon resin layer. --

(19) In Claim p.28, Claim 12 (English translation p.36 Claim 12) is amended as shown below.

-- A photocatalyst sheet as set forth in claim 11, characterized in that said second and said third fluorocarbon resin layers are made of identical fluorocarbon resin. --

(20) In Claim p.28, Claim 13 (English translation p.36 Claim 13) is amended as shown below.

-- A photocatalyst sheet as set forth in claim 8 or 9, characterized in that the melting point of said first fluorocarbon resin layer is as high as, or higher than, that of said second fluorocarbon resin layer. --

(21) In Claim p.28, Claim 14 (English translation p.36 Claim 14) is amended as shown below.

-- A photocatalyst sheet as set forth in claim 13, characterized in that said first and said second fluorocarbon resin layers are made of identical fluorocarbon resin. --

(22) In Claim p.28, Claims 15 – 17 and page 29, Claim 18 (English translation p.36 Claims 15 – 18) are deleted.

(23) In Claim page 29, Claim 19 (English translation p.36 – 37, Claim 19) is amended as shown below.

-- A photocatalyst sheet comprising a substrate, a fluorocarbon resin layer coated on said substrate, and at least an uppermost layer coated with a fluorocarbon resin layer containing photocatalysts, characterized in that a surface of said fluorocarbon resin layer containing photocatalysts is water repellant upon ultraviolet light irradiation. --

(24) In Claim page 29, Claim 20 (English translation p.37, Claim 20) is amended as shown below.

-- A photocatalyst sheet as set forth in claim 8 or 9, characterized in that photocatalysts are contained in said second fluorocarbon resin layer. --

(25) In Claim page 29, Claim 21, Line 4 (English translation p.37, Claim 21, Lines 1 – 2) “claims 1 – 20” is amended to

-- claims 8, 9, and 19 --

(26) In Claim page 29, Claim 22, Line 4 (English translation p.37, Claim 22, Lines 1 – 2) “claims 1 – 20” is amended to

-- claims 8, 9, and 19 --

(27) In Claim page 29, Claim 23, Line 2 (English translation p.37, Claim 23, Lines 1 – 2) “claims 1 – 20” is amended to

-- claims 8, 9, and 19 --

(28) In Claim page 29, Claim 24, Line 2 (English translation p.37, Claim 24, Lines 1 – 2) “any one of claims 1 – 23” is amended to

-- claim 8 or 9 --

(29) In Claim page 29, Claim 25 (English translation p.38, Claim 25) is amended as shown below.

-- A manufacturing method of a photocatalyst sheet, which comprises:

a substrate made of glass fiber;

a first fluorocarbon resin layer made of PTFE coated on said substrate;

a second fluorocarbon resin layer made of either one of PTFE, FEP, or PFA coated on said first fluorocarbon resin layer; and

a third fluorocarbon resin layer made of FEP containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on said second fluorocarbon resin layer;

of which said photocatalysts have the part exposed on said third fluorocarbon resin layer, the ratio of said photocatalysts in said third fluorocarbon resin layer is 10 – 60 weight %, and the surface of said fluorocarbon resin layer containing said photocatalysts of said photocatalyst sheet is water repellent upon ultraviolet light irradiation, and

said method being characterized to comprise

a process of coating the first fluorocarbon resin layer on the substrate;

a process of coating the second fluorocarbon resin layer on said first fluorocarbon resin layer; and

a process of coating the third fluorocarbon resin layer containing photocatalysts on said second fluorocarbon resin layer. --

(30) In Claim page 30, Claim 26 (English translation p.38, Claim 26) is amended as shown below.

-- A manufacturing method of a photocatalyst sheet, which comprises:

a substrate made of glass fiber;

a first fluorocarbon resin layer made of PTFE coated on said substrate;

a second fluorocarbon resin layer made of either one of PTFE, FEP, or PFA containing photocatalysts coated on said first fluorocarbon resin layer; and

a third fluorocarbon resin layer made of FEP containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on said second fluorocarbon resin layer;

of which said photocatalysts have the part exposed on said third fluorocarbon resin layer,

the ratio of said photocatalysts in said third fluorocarbon resin layer is 10 – 60 weight %, and the surface of said fluorocarbon resin layer containing said photocatalysts of said photocatalyst sheet is water repellent upon ultraviolet light irradiation, and

said method being characterized to comprise

a process of coating the first fluorocarbon resin layer on the substrate;

a process of coating the second fluorocarbon resin layer containing photocatalysts on said first fluorocarbon resin layer; and

a process of coating the third fluorocarbon resin layer containing photocatalysts on said second fluorocarbon resin layer. --

(31) In Claim page 30, Claims 27 and 28 (English translation p.38 Claims 27 and 28) are deleted.

(32) In Claim page 30, Claim 29, Lines 3 – 4 (English translation p.38, Claim 29, Line 2) “any one of claims 26 – 28” is amended to
-- claim 25 or 26 --

(33) In Claim page 30, Claim 30, Line 3 (English translation p.39, Claim 30, Line 2) “any one of claims 26 – 29” is amended to
-- claim 25 or 26 --

(34) In Claim page 30, Claim 31, Lines 5 – 6 (English translation p.39, Claim 31, Line 2) “claims 26 – 30” is amended to
-- claims 25, 29, 30 --

6. List of Attached Documents

(1) Specification substitute sheet pages 3, 4, 4/1, 5, 5/1, 6, 6/1, 7 (English translation substitute sheet pages 4, 4/1, 5, 6, 6/1, 7, 8, 8/1, 9).

(2) Claim pages 27, 28, 28/1, 29, 29/1, 30, 30/1 (English translation substitute sheet pages 34, 34/1, 35, 35/1, 36, 37, 38, 38/1, 39).

the ultraviolet light (hereinafter the abbreviated term UV to be appropriately used) irradiation.

Disclosure of the Invention

[0010] The first purpose of the present invention is, considering the above mentioned problem, to offer a new photocatalyst sheet in which substrates coated with fluorocarbon resin are readily weldable mutually, and also of a high antifouling property by coating the outermost surface of film/fabric structure with fluorocarbon resin containing photocatalyst and the method of manufacturing the same.

The second purpose of the present invention is, with reference to the above-mentioned problems, to offer a new photocatalyst sheet in which the uppermost surface of a substrate is coated with fluorocarbon resin layer containing a photocatalyst, said uppermost surface has water repellancy, and which has a high antifouling property when UV is irradiated on said uppermost surface, and the method of manufacturing the same.

[0011] In order to achieve the above mentioned first and second purposes, the first embodiment of the present invention is characterized in that the structure of a photocatalyst sheet of the present invention comprises: a substrate made of glass fiber; a first fluorocarbon resin layer made of PTFE coated on said substrate; a second fluorocarbon resin layer made of either one of PTFE, FEP, or PFA coated on said first fluorocarbon resin layer; and a third fluorocarbon resin layer made of FEP containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on said second fluorocarbon resin layer, of which said photocatalysts have the part exposed on said third fluorocarbon resin layer, and the ratio of said photocatalysts in said third fluorocarbon resin layer is 10 – 60 weight %, and the surface of the fluorocarbon resin layer containing said photocatalysts of said photocatalyst sheet has water repellency upon ultraviolet light irradiation.

In the embodiment described above, the surface state of the substrate made of glass fiber is preferably either smooth, rough, or mesh-like. The second fluorocarbon resin layer may contain

photocatalysts.

Preferably, the photooxidation ability of the surface of the fluorocarbon resin layer containing photocatalysts of a photocatalyst sheet is such that, when oleic glyceride is coated on said surface of a fluorocarbon resin layer, and ultraviolet light is irradiated onto said surface by 1mW/cm^2 , the rate of decomposition of said oleic glyceride is 0.1mg/cm^2 day or more.

Preferably, the photoreduction ability of the surface of the fluorocarbon resin layer containing photocatalysts of a photocatalyst sheet is such that, when said photocatalyst sheet is soaked in the 0.1N (normal) silver nitrate aqueous solution, and ultraviolet light is irradiated for one minute onto the surface of said fluorocarbon resin layer containing said photocatalysts by 1mW/cm^2 , the color difference change is $\Delta E^* \geq 1$.

The contact angle of the surface of the fluorocarbon resin layer containing photocatalysts is preferably about 90 degrees or more. The thickness of the fluorocarbon resin layer containing photocatalysts is preferably $1\text{ }\mu\text{m}$ or more.

[0012] By the embodiment described above since the melting point of FEP of the outer most layer containing the photocatalyst is lower than that of PTFE of the first fluorocarbon resin layer on the substrate made of glass fiber, the thermal welding between photocatalyst sheets is readily achieved, and the surface of the fluorocarbon resin layer containing photocatalysts contained in the uppermost layer of the photocatalyst sheet has water repellency upon ultraviolet light irradiation, and high antifouling property is given by the redox reaction when the photocatalysts exposed on the surface of the third fluorocarbon resin of the photocatalyst sheet are irradiated with the ultraviolet light involved in the sunshine.

[0013] The embodiment of the present invention is characterized by the higher melting point of the first fluorocarbon resin layer than those of the second and the third fluorocarbon resin layer, and the melting point of the second fluorocarbon resin layer higher than, or as high as, that of the third fluorocarbon resin layer. The second and the third fluorocarbon resin layers may be made of the identical resin.

The present invention is also characterized by the higher melting point of the first fluorocarbon resin layer than those of the second and the third fluorocarbon resin layers, and the melting point of the first fluorocarbon resin layer higher than, or as high as, that of the second fluorocarbon resin layer. The first and the second fluorocarbon resin layers may be made of the identical resin. The first and the third fluorocarbon resin layers may be made of the identical resin.

[0014]

[0015] In order to achieve the above mentioned first purpose, the second embodiment of the present invention is characterized in that the structure of a photocatalyst sheet of the present invention comprises: a substrate; a first fluorocarbon resin layer coated on the substrate; a second fluorocarbon resin layer coated on the first fluorocarbon resin layer; and a third fluorocarbon resin layer containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on the second fluorocarbon resin layer, of which the third fluorocarbon resin layer has lower melting point than the first fluorocarbon resin layer, the photocatalysts have the part exposed on the third fluorocarbon resin layer, and the ratio of the photocatalysts in the third fluorocarbon resin layer is 10 – 60 weight %, and the third fluorocarbon resin layer is thermally weldable.

In order to achieve the above mentioned second purpose, the third embodiment of the present invention is such that the structure of a photocatalyst sheet of the present invention comprises: a substrate; a first fluorocarbon resin layer coated on the substrate; a second fluorocarbon resin layer coated on the first fluorocarbon resin layer; and a third fluorocarbon resin layer containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on the second fluorocarbon resin layer, of which the third fluorocarbon resin layer has lower melting point than the first fluorocarbon resin layer, the photocatalysts have the part exposed on the third fluorocarbon resin layer, and the ratio of the photocatalysts in the third fluorocarbon resin layer is 10 – 60 weight %, the surface of the fluorocarbon resin layer containing photocatalysts of the photocatalyst sheet is water repellent upon ultraviolet light irradiation, and the third fluorocarbon resin layer is thermally weldable.

In the embodiment described above, the substrate is preferably made of glass fiber, and its surface state is either smooth, rough, or mesh-like. The first fluorocarbon resin layer is made of PTFE, the second fluorocarbon resin layer is made of either one of PTFE, FEP, or PFA, and the third fluorocarbon resin layer is made of FEP.

Preferably, the melting point of the second fluorocarbon resin

layer may be as high as, or higher than, that of the third fluorocarbon resin layer. In this case, the second and the third fluorocarbon resin layers may be made of identical fluorocarbon resin.

Preferably, the melting point of the first fluorocarbon resin layer may be as high as, or higher than, that of the second fluorocarbon resin layer. In this case, the first and the second fluorocarbon resin layers may be made of identical fluorocarbon resin. Also, the second fluorocarbon resin layer may contain photocatalysts.

In order to achieve the above mentioned second purpose, the fourth embodiment of the present invention is characterized in that a photocatalyst sheet of the present invention has a substrate which is coated with fluorocarbon resin layers, at least its uppermost layer is coated with the fluorocarbon resin layer containing photocatalysts, and the surface of the fluorocarbon resin layer containing photocatalysts is water repellent upon ultraviolet light irradiation.

By each of the embodiments described above, the combination of the first to the third fluorocarbon resin layers, which gives excellent thermal weldability between photocatalyst sheets, can be readily obtained. Especially when a substrate is glass fiber, the first fluorocarbon resin layer is PTFE, the second fluorocarbon resin layer is either one of PTFE, FEP, or PFA, and the third fluorocarbon resin layer is FEP, since FEP as the uppermost fluorocarbon resin layer containing photocatalysts has lower melting point than PTFE as the first fluorocarbon resin layer on the substrate side, photocatalyst sheets can be easily thermally welded to each other. Also, high antifouling property is given by the redox reaction when the photocatalysts exposed on the surface of said third fluorocarbon resin are irradiated with the ultraviolet light involved in the sunshine. Further, the surface of the fluorocarbon resin layer containing photocatalysts of the uppermost layer of a photocatalyst sheet can be given water repellency upon ultraviolet light irradiation.

[0016] Preferably, the photooxidation ability of the surface of said fluorocarbon resin layer containing the photocatalyst is such that, when oleic glyceride is coated on said surface of fluorocarbon resin layer, and an ultraviolet light is irradiated onto said surface by $1\text{mW}/\text{cm}^2$, the rate of decomposition of said oleic glyceride is $0.1\text{mg}/\text{cm}^2$ day or more.

The photoreduction ability of the surface of said fluorocarbon resin layer containing the photocatalyst is such that, when said photocatalyst sheet is soaked in the 0.1N (normal) silver nitrate aqueous solution, and an ultraviolet light is irradiated for one minute onto the surface of said fluorocarbon resin layer containing the photocatalyst by $1\text{mW}/\text{cm}^2$, the color difference change is preferably $\Delta E^* \geq 1$.

The contact angle of the surface of fluorocarbon resin layer containing photocatalyst is preferably about 90 degrees or more.

According to the above-mentioned embodiment, when the UV light contained in the sunshine or the fluorescent light having the energy higher than the forbidden gap of the photocatalyst is irradiated onto said photocatalyst, the high antifouling property is attained by the decomposition of the organics accreted on the photocatalyst sheet surface by the redox reaction of the photocatalyst. The contact angle with water of the uppermost fluorocarbon resin layer surface of the photocatalyst sheet of the present invention can be made about 90° or more as an index of water-repellent property.

[0017] In the embodiment described above, the thickness of fluorocarbon resin layer containing the photocatalyst is $1\mu\text{m}$ or more. In this case since said substrate is made of fiber, and its surface has proper surface roughness, the surface area of the photocatalyst can be made larger per unit area compared with the flat and smooth surface, thereby the high antifouling property can be attained. Consequently, when the contaminant is accreted on fluorocarbon resin layer containing the photocatalyst, a high antifouling property can be attained by the redox function of the photocatalyst located in the three dimensional orientation around it owing to surface roughness. Mutual thermal weldability of the photocatalyst sheets can also be made better.

[0018] A manufacturing method of a photocatalyst sheet of the present

invention is that of a photocatalyst sheet, which comprises: a substrate made of glass fiber; a first fluorocarbon resin layer made of PTFE coated on the substrate; a second fluorocarbon resin layer made of either one of PTFE, FEP, or PFA coated on the first fluorocarbon resin layer; and a third fluorocarbon resin layer made of FEP containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on the second fluorocarbon resin layer, of which the photocatalysts have the part exposed on the third fluorocarbon resin layer, the ratio of the photocatalysts in the third fluorocarbon resin layer is 10 – 60 weight %, and the surface of the fluorocarbon resin layer containing the photocatalysts of the photocatalyst sheet is water repellent upon ultraviolet light irradiation, and said method is characterized to comprise a process of coating the first fluorocarbon resin layer on the substrate, a process of coating the second fluorocarbon resin layer on the first fluorocarbon resin layer, and a process of coating the third fluorocarbon resin layer containing photocatalysts on the second fluorocarbon resin layer.

Another manufacturing method of a photocatalyst sheet of the present invention is that of a photocatalyst sheet, which is characterized to comprise: a substrate made of glass fiber; a first fluorocarbon resin layer made of PTFE coated on the substrate; a second fluorocarbon resin layer made of either one of PTFE, FEP, or PFA coated on the first fluorocarbon resin layer; and a third fluorocarbon resin layer made of FEP containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on the second fluorocarbon resin layer, of which the photocatalysts have the part exposed on the third fluorocarbon resin layer, the ratio of the photocatalysts in the third fluorocarbon resin layer is 10 – 60 weight %, and the surface of the fluorocarbon resin layer containing said photocatalysts of the photocatalyst sheet is water repellent upon ultraviolet light irradiation, and said method is characterized to comprise a process of coating the first fluorocarbon resin layer on the substrate, a process of coating the second fluorocarbon resin layer containing photocatalysts on the first fluorocarbon resin layer, and a process of coating the third fluorocarbon resin layer containing photocatalysts on

the second fluorocarbon resin layer.

By said method of manufacturing, coating the third fluorocarbon resin layer containing photocatalysts on the uppermost surface of the substrate makes thermal welding easy, and the photocatalysts exposed on the third fluorocarbon resin layer have water repellency upon ultraviolet light irradiation, thereby a photocatalyst sheet having antifouling property can be manufactured at low cost.

Further, in case that the second fluorocarbon resin layer contains photocatalysts, since both the second and the third fluorocarbon resin layers contain photocatalysts, a photocatalyst sheet having excellent thermal weldability and antifouling property can be manufactured.

[0019] As for the embodiment described above, the coating process of the first fluorocarbon resin layer, the second fluorocarbon resin layer either containing or not containing the photocatalyst, and the third fluorocarbon resin layer containing the photocatalyst is preferably conducted continuously. By this embodiment the photocatalyst sheet comprising the first to the third fluorocarbon resin layer continuously coated on the substrate and the third fluorocarbon resin layer containing the photocatalyst on the outermost surface may be efficiently manufactured.

[0020] As for the embodiment described above, the third fluorocarbon resin layer containing the photocatalyst may be coated on the substrate that has been coated beforehand with the first and the second fluorocarbon resin layers. By this embodiment, the manufacture of the photocatalyst sheet may be possible by first preparing the substrate coated with the first and the second fluorocarbon resin layers beforehand and by coating the third fluorocarbon resin layer containing the photocatalyst anytime later.

[0021] The coating process of the third fluorocarbon resin layer containing the photocatalyst characteristically comprises: a coating process of the dispersion for fluorocarbon resin containing the titanium oxide fine particles as the photocatalyst on the second fluorocarbon resin

layer; a drying process; a sintering process at the temperature higher than the melting point of the resin for the third fluorocarbon resin layer; and a process to make the photocatalyst exposed on the surface of the third fluorocarbon resin layer. By this embodiment, the third fluorocarbon resin layer containing the photocatalyst may be sintered on the first and the second fluorocarbon resin layers on substrate and the photocatalyst sheet with excellent thermal bondability and the antifouling property may be manufactured.

[0022]

Brief Description of the Drawings

[0023]

Fig. 1 is a schematic cross-sectional view illustrating the structure of a photocatalyst sheet according to the present invention as one form of embodiment thereof.

Fig. 2 is another schematic cross-sectional view illustrating the structure of a photocatalyst sheet according to the present invention.

Fig. 3 is a cross-sectional view showing the other structure of a photocatalyst sheet of the present invention.

Fig. 4 is an enlarged cross-sectional view showing the structure of the substrate surface coated with the third fluorocarbon resin layer containing the photocatalyst of the present invention.

Fig. 5 is a flowchart of the processes to manufacture a photocatalyst sheet of the present invention.

Fig. 6 is the table of the composition of a dispersion used to

Claims:

What is claimed is:

1. (amended) A photocatalyst sheet characterized in that it comprises:

a substrate made of glass fiber;

a first fluorocarbon resin layer made of PTFE coated on said substrate;

a second fluorocarbon resin layer made of either one of PTFE, FEP, or PFA coated on said first fluorocarbon resin layer; and

a third fluorocarbon resin layer made of FEP containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on said second fluorocarbon resin layer;

of which said photocatalysts have the part exposed on said third fluorocarbon resin layer;

the ratio of said photocatalysts in said third fluorocarbon resin layer is 10 – 60 weight %; and

the surface of the fluorocarbon resin layer containing said photocatalysts of said photocatalyst sheet is water repellent upon ultraviolet light irradiation.

2. (amended) A photocatalyst sheet as set forth in claim 1, characterized in that the surface state of said substrate made of glass fiber is either smooth, rough, or mesh-like.

3. (amended) A photocatalyst sheet as set forth in claim 1, characterized in that photocatalysts are contained in said second fluorocarbon resin layer.

4. (amended) A photocatalyst sheet as set forth in claim 1, characterized in that the photooxidation ability of the surface of said fluorocarbon resin layer containing photocatalysts of said photocatalyst sheet is such that, when oleic glyceride is coated on said surface of fluorocarbon resin layer, and an ultraviolet light is irradiated onto said

surface by $1\text{mW}/\text{cm}^2$, the rate of decomposition of said oleic glyceride is $0.1\text{mg}/\text{cm}^2$ day or more.

5. (amended) A photocatalyst sheet as set forth in claim 1, characterized in that the photoreduction ability of the surface of said fluorocarbon resin layer containing photocatalysts of said photocatalyst sheet is such that, when said photocatalyst sheet is soaked in the 0.1N (normal) silver nitrate aqueous solution, and ultraviolet light is irradiated for one minute onto the surface of said fluorocarbon resin layer containing photocatalysts by $1\text{mW}/\text{cm}^2$, the color difference change is $\Delta E^* \geq 1$.

6. (amended) A photocatalyst sheet as set forth in claim 1, characterized in that the contact angle of the surface of said fluorocarbon resin layer containing photocatalysts is about 90 degrees or more.

7. (amended) A photocatalyst sheet as set forth in claim 1, characterized in that the thickness of said fluorocarbon resin layer containing photocatalysts is 1 μ m or more.

8. (amended) A photocatalyst sheet characterized in that it comprises:

- a substrate;

- a first fluorocarbon resin layer coated on said substrate;

- a second fluorocarbon resin layer coated on said first fluorocarbon resin layer; and

- a third fluorocarbon resin layer containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on said second fluorocarbon resin layer;

- of which said third fluorocarbon resin layer has lower melting point than said first fluorocarbon resin layer;

- said photocatalysts have the part exposed on said third fluorocarbon resin layer;

- the ratio of said photocatalysts in said third fluorocarbon resin layer is 10 – 60 weight %; and

- said photocatalyst sheet can be thermally welded to said third fluorocarbon resin layer.

9. (amended) A photocatalyst sheet characterized in that it comprises:

- a substrate;

- a first fluorocarbon resin layer coated on said substrate;

- a second fluorocarbon resin layer coated on said first fluorocarbon resin layer; and

- a third fluorocarbon resin layer containing photocatalysts

consisting at least of titanium oxide (TiO_2 , TiO_3) coated on said second fluorocarbon resin layer;

of which said third fluorocarbon resin layer has lower melting point than said first fluorocarbon resin layer;

said photocatalysts have the part exposed on said third fluorocarbon resin layer;

the ratio of said photocatalysts in said third fluorocarbon resin layer is 10 – 60 weight %;

the surface of the fluorocarbon resin layer containing said photocatalysts of said photocatalyst sheet is water repellent upon ultraviolet light irradiation, and

said photocatalyst sheet can be thermally welded to said third fluorocarbon resin layer.

10. (amended) A photocatalyst sheet as set forth in claim 8 or 9, characterized in that said substrate is made of glass fiber, its surface state is either smooth, rough, or mesh-like, said first fluorocarbon resin layer is made of PTFE, said second fluorocarbon resin layer is either one of PTFE, FEP, or PFA resin layer, and said third fluorocarbon resin layer is made of FEP.

11. (amended) A photocatalyst sheet as set forth in claim 8 or 9, characterized in that the melting point of said second fluorocarbon resin layer is as high as, or higher than, that of said third fluorocarbon resin layer.

12. (amended) A photocatalyst sheet as set forth in claim 11, characterized in that said second and said third fluorocarbon resin layers are made of identical fluorocarbon resin.

13. (amended) A photocatalyst sheet as set forth in claim 8 or 9, characterized in that the melting point of said first fluorocarbon resin layer is as high as, or higher than, that of said second fluorocarbon resin layer.

14. (amended) A photocatalyst sheet as set forth in claim 13, characterized in that said first and said second fluorocarbon resin layers are made of identical fluorocarbon resin.

15. (deleted)

16. (deleted)

17. (deleted)

18. (deleted)

19. (amended) A photocatalyst sheet comprising a substrate, a fluorocarbon resin layer coated on said substrate, and at least an uppermost layer coated with a fluorocarbon resin layer containing photocatalysts, characterized in that a surface of said fluorocarbon resin layer containing photocatalysts is water repellent upon ultraviolet light irradiation.

20. (amended) A photocatalyst sheet as set forth in claim 8 or 9, characterized in that photocatalysts are contained in said second fluorocarbon resin layer.

21. (amended) photocatalyst sheet as set forth in any one of claims 8, 9, and 19, characterized in that the photooxidation ability of the surface of said fluorocarbon resin layer containing the photocatalyst is such that, when oleic glyceride is coated on said surface of fluorocarbon resin layer, and an ultraviolet light is irradiated onto said surface by 1mW/cm^2 , the rate of decomposition of said oleic glyceride is 0.1mg/cm^2 day or more.

22. (amended) photocatalyst sheet as set forth in any one of claims 8, 9, and 19, characterized in that the photoreduction ability of the surface of said fluorocarbon resin layer containing the photocatalyst is such that, when said photocatalyst sheet is soaked in the 0.1N (normal) silver nitrate aqueous solution, and an ultraviolet light is irradiated for one minute onto the surface of said fluorocarbon resin layer containing the photocatalyst by 1mW/cm^2 , the color difference change is $\Delta E^* \geq 1$.

23. (amended) A photocatalyst sheet as set forth in any one of claims 8, 9, and 19, characterized in that the contact angle of the surface of said fluorocarbon resin layer containing the photocatalyst is about 90 degrees or more.

24. (amended) A photocatalyst sheet as set forth in any one of claim 8 or 9, characterized in that the thickness of said fluorocarbon resin layer containing the photocatalyst is $1\ \mu\text{m}$ or more.

25. (amended) A manufacturing method of a photocatalyst sheet, which comprises:

a substrate made of glass fiber;

a first fluorocarbon resin layer made of PTFE coated on said substrate;

a second fluorocarbon resin layer made of either one of PTFE, FEP, or PFA coated on said first fluorocarbon resin layer; and

a third fluorocarbon resin layer made of FEP containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on said second fluorocarbon resin layer;

of which said photocatalysts have the part exposed on said third fluorocarbon resin layer, the ratio of said photocatalysts in said third fluorocarbon resin layer is 10 – 60 weight %, and the surface of said fluorocarbon resin layer containing said photocatalysts of said photocatalyst sheet is water repellent upon ultraviolet light irradiation, and

said method being characterized to comprise

a process of coating the first fluorocarbon resin layer on the substrate;

a process of coating the second fluorocarbon resin layer on said first fluorocarbon resin layer; and

a process of coating the third fluorocarbon resin layer containing photocatalysts on said second fluorocarbon resin layer.

26. (amended) A manufacturing method of a photocatalyst sheet, which comprises:

a substrate made of glass fiber;

a first fluorocarbon resin layer made of PTFE coated on said substrate;

a second fluorocarbon resin layer made of either one of PTFE, FEP, or PFA containing photocatalysts coated on said first fluorocarbon resin layer; and

a third fluorocarbon resin layer made of FEP containing photocatalysts consisting at least of titanium oxide (TiO_2 , TiO_3) coated on

said second fluorocarbon resin layer;

of which said photocatalysts have the part exposed on said third fluorocarbon resin layer, the ratio of said photocatalysts in said third fluorocarbon resin layer is 10 – 60 weight %, and the surface of said fluorocarbon resin layer containing said photocatalysts of said photocatalyst sheet is water repellent upon ultraviolet light irradiation, and

said method being characterized to comprise

a process of coating the first fluorocarbon resin layer on the substrate;

a process of coating the second fluorocarbon resin layer containing photocatalysts on said first fluorocarbon resin layer; and

a process of coating the third fluorocarbon resin layer containing photocatalysts on said second fluorocarbon resin layer.

27. (deleted)

28. (deleted)

29. (amended) A manufacturing method of a photocatalyst sheet as set forth in claim 25 or 26, characterized in that coating processes are continuous for said first fluorocarbon resin layer, said second fluorocarbon resin layer, either containing or not containing the photocatalyst, and said third fluorocarbon resin layer containing the photocatalyst.

30. (amended) A manufacturing method of a photocatalyst sheet as set forth in claim 25 or 26, characterized in that a coating process is such that first preparing said first and the second fluorocarbon resin layers and then coating the third fluorocarbon resin layer containing the photocatalyst.

31. (amended) A manufacturing method of a photocatalyst sheet as set forth in any one of claims 25, 29, 30, characterized in that the coating process of said third fluorocarbon resin layer containing the photocatalyst consists of:

- a coating process of the dispersion for fluorocarbon resin containing titanium oxide fine particles as the photocatalyst;

- a drying process;

- a sintering process at the temperature higher than the melting point of the resin for said third fluorocarbon resin layer; and

- a process to make said photocatalyst exposed on the surface of said third fluorocarbon resin layer.